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then surely *Ambocœlia* is not worthy of separation from *Spirifer* as a distinct genus.

The work as a whole is a valuable acquisition to the literature of palæontology, and will be warmly welcomed by all students of the brachipoda.

S. W.

Istidens foraminiferer i Danmark og Holsten og deres betydning for studiet af istidens aflejringer [The foraminifera of the Ice-Age in Denmark and Holsten and their significance in the study of the glacial deposits.] By VICTOR MADSEN, Meddelelser fra Dansk Geologisk Forening, No 2, Copenhagen, 1895. 225 pp.

The first part of this paper gives a review of the classifications by different geologists of the drift deposits of northern Europe, England and Denmark. A new classification is then proposed, mainly based on evidences of climatic changes in the Quaternary Age, as the author interprets them from observations in Denmark. His scheme runs as follows:

1). Preglacial sedimentary deposits with a temperate fauna and flora. Weybourn crag, Cromer forest-bed in England.

2). Preglacial sedimentary deposits with a boreal or arctic fauna and flora. Ledamyalis-bed, arctic fresh water-bed in England. Yoldia-clay in eastern Prussia. The older Yoldia-clay in Vendsyssel, Denmark (?).

3). Morainic deposits from the Norwegian ice-current in Denmark, northwest Germany, Holland, Belgium, and on the east coast of England.

4). Interglacial sedimentary deposits with an arctic or boreal fauna and flora. Older Yoldia-clay in Vendsyssel ? Yoldia-clay at Esbjerg (Denmark) ? etc.

5). Interglacial sedimentary deposits with a temperate fauna and flora. Cyprina-clay, etc., in Denmark, Holstein, Rügen and Prussia.

6). Interglacial sedimentary deposits with boreal or arctic fauna and flora. Yoldia-clay at Esbjerg.

7). Morainic deposits from the older Baltic ice-current in Denmark, Skåne, northern Germany and northern Holland.

8). Morainic deposits from an ice-current which moved in a direction from N. E. to S. W. in Holland, Skåne and possibly in Denmark.

9). Interglacial sedimentary deposits with arctic and boreal fauna and flora. Older Dryas-clay in Skåne and Denmark.

10). Morainic deposits from the second Baltic ice-current over the lower tracts of Skåne, the Danish Islands, the east coast of Jutland, and the north coast of Germany.

11). Late glacial sedimentary deposits with arctic fauna and flora, perhaps partly of the same age as the preceding. The latest Yoldia-clay in Vendsyssel, Sweden and Norway. Latest Dryas-clay in Skåne, Denmark, and northern Germany.

12). Late glacial sedimentary deposits with boreal fauna and flora. Glacial shell-beds in Sweden and Norway, Zirphæa-bed in Vendsyssel.

"This classification of the diluvial deposits," the author says, "is only a hypothesis, but it appears to me that it better than those in use heretofore explains the many intricate relations of the drift, and that it will serve better than these as a working hypothesis in geological investigations on the diluvial deposits of Denmark. It hardly rests on any more uncertain foundation than the hypothesis in vogue at the present time, and like all these it is very much in need of verification." The first ice period in Geikie's classification, that represented by the Weyburn crag, is set aside expressly, and so is also Geikie's fifth glacial period. The Norway ice-current is believed to have been older than the oldest Baltic ice-current, and the opinion is expressed that the time of the former was separated from that of the latter by an interglacial period, during which the ice left the land entirely. The evidence adduced in favor of this view is the presence of Norwegian bowlders in the lowest moraines in Denmark, and in the drift which lies south of the southern border of the Baltic moraine in northern Europe. It is not considered as probable that the Norway current could have been diverted by the Baltic current to such an extent in the same glacial period, as to have first deposited its material in northern Denmark, and later on in the same age have laid down its moraine in England.

The author urges the importance of the study of the fossils of the drift. The greater part of the paper gives the results of his studies of the foraminifera in the drift of Denmark. These fossils are small and have often been well preserved, where larger fossils have been crushed. These organisms are marine, and when found, they often give decisive evidence as to the circumstances of their deposition, for many of them are dependent on certain conditions of climate and on the depth and relative saltness of the sea. In studying the marine diluvium of Denmark, the author has found it insufficient to make the basis of classification consist of the structure of the beds and the character of the previously known fauna only. He now proposes the following classification based on the differences in the foraminifera contained in these beds.

a. Deposits with a temperate fauna, comprising formations of interglacial age (probably in every locality studied). A part of these beds seem to belong to an age of comparatively warm climate, while another part appears to belong to a period of comparatively cold climate.

b. Deposits with an arctic or boreal fauna. This division comprises:

I. The older Yoldia-clay.

II. The later Yoldia-clay.

III. The Zirphæa-bed.

The Cyprina clay belongs to the deposits that have a temperate fauna. Of its 13 foraminifera, eight forms are cosmopolitan in their habitat, two are found in southern waters, ranging as far North as to the Shetland Islands, while two are northern forms occurring as far South as Valencia. One form is not known in the present seas. This indicates climatic conditions identical with the present. The nature of the molluscan fauna of this clay corroborates this evidence. A summary is made of the literature on the structural relations of the Cyprina-clay. While the author admits that its exposures, so far as observed in Denmark, do not decidedly speak against the view that it is preglacial, he believes that there are good grounds for regarding it as being formed later than the oldest border clay on these islands. It has in no place been seen in an undisturbed condition under the bowlder clay and resting directly on preglacial deposits. The bowlder clay associated with it often contains a large number of foraminifera, but it lacks those forms which are characteristic of the Cyprina-clay. Hence this bowlder clay can not very well be later than the Cyprina-clay, for, if this were older some of its fossils would have been likely to have become mixed into the superimposed morainic material. The high and varied tilting of the bed in most localities indicates, however, that it has been disturbed by glacial action at some time. In samples of a gray clay from Jutland, the author has found a fauna also indicating a temperate climate.

In Holstein several localities have beds of gravel, sand, and clay with foraminifera and molluscs indicating biological conditions "answering to those now obtaining between western part of Norway and the British Islands." These beds are regarded as interglacial except in one instance, where they are seen to rest on tertiary rocks. They are probably not all of the same age. From three other localities 19 species of foraminifera have been collected, and these indicate a climate like that now prevailing about the Lofoden Islands. The structural relations in this case are unknown.

The author evinces a particular acquaintance with the geology of the Yoldia-clays. The older Yoldia-clay contains Norwegian bowlders but lacks any admixture of materials carried by the Baltic ice, the moraine of which overlies it unconformably. This clay may have been laid down either right before or soon after the invasion of the Norway ice-current. At any rate it was there before the last advance of the Baltic ice. From the 64 species of foraminifera, which have been identified as occurring in this bed, it is inferred that boreal and arctic climates prevailed during its forming. Such indications also exist in the molluscan fauna. The dissimilarities among some of the localities render it probable that all of these do not belong to exactly the same age. In most places this clay has been either tilted or contorted by subsequent glacial action.

The later Yoldia-clay is never overlaid by morainic material and is always found undisturbed. For this reason it is separated from the older clay. It was probably formed soon after the last glaciation of the northern part of Denmark, and possibly in part at the time of the second Baltic ice-current, which probably did not reach this region. This clay has yielded 36 species of foraminifera: 24 are cosmopolitan, four are arctic forms. Of the mollusca most of the forms are now found near Spitzbergen and Greenland. The fauna has a more decided arctic character than has that of the older Yoldia-clay.

The Zirphæa-bed has been observed only on the northern point of Jutland. It resembles the Swedish and Norwegian glacial shell-beds and consists of gravel and sand. Its fossils are found *in situ* and also worked down into the underlying Yoldia-clay. Of the 41 species of foraminifera found, 26 are cosmopolitan, four are arctic and boreal, five occur in the North Atlantic. From this and from the nature of the molluscan fauna, it is inferred that the climate prevailing when this bed was forming, was almost arctic, resembling the present conditions on the west coast of Finland.

Samples of non-marine clays have also been examined, and the author has found in these (white glacier clay and other fresh water clays) a much smaller number of foraminifera, some of which are certain to belong to the underlying older formations of the Tertiary and Quaternary ages. This is just the reverse of what is the case in the marine deposits, in which foraminifera are abundant and in which specimens belonging to the older formations are exceedingly rare.

These minute animal remains, therefore, give important evidence as to (1) the physical condition under which deposits are made, whether in the open sea, fiords, or in lakes; (2) the climatic conditions, and (sometimes) (3) the geological age.

An appendix contains an annotated catalogue of the 86 species of the foraminifera found in the marine diluvium of Denmark; a map indicates the localities where the samples of the drift examined have been taken, and a plate illustrates several species, one of which is new.

The paper is evidently prepared with care and after a thorough study of the previous work of other geologists in the same field, and after critical observations on many localities by the author himself. A cautious conservatism pervades the statement of facts and arguments. While expressing his belief that the drift in Denmark can best be explained as the result of three separate glacial periods, Mr. Madsen seems to take particular care not to overrate the significance of such observations as support this theory, and to treat this as a question still in need of a positive answer from that country.

J. A. UDDEN.

Om Lommalerans ålder. By N. O. HOLST and JOH. CHR. MOBERG (Sveriges geologiska undersökning, Afhandlingar och uppsatser, No. 149).

One of the localities in southern Sweden regarded as furnishing evidence for an interglacial period is near Lomma station on the coast of Öre sound. Excavations have here been made into a clay, which furnishes material for the manufacture of brick and cement. The deposit is about twelve feet in thickness, it is bedded and lies at a level of about 45 feet above the sea and about 28 feet above the highest postglacial beaches in the vicinity. The authors have lately studied the locality critically, and maintain that the Lomma clay is a marine glacial deposit, and not interglacial, as De Geer contends.

The evidence presented in support of their views is, in the first